10/089667
JC13 Rec'd PCT/PTO 02 APR 2002
[10191/2352]

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METHOD AND DEVICE FOR CONTROLLING AN ENGINE

Background Information

The present invention relates to a method and a device for controlling an engine.

A quantity controller and a method and a device for checking a sensor for detecting the position of a quantity controller are known from German Patent 40 33 049. With the method described there, a check is performed when the quantity controller is switched to currentless to determine whether a needle motion sensor or a corresponding sensor is delivering an output signal.

In addition, there are known methods in which various signals are subjected to a plausibility check with the other signals.

When using an injection quantity signal in particular, the plausibility check with other signals is problematical because with today's systems, there are often injections that do not make any contribution to engine torque. These include, for example, pre-injections before the actual injection and post-injections, which are used in particular for exhaust gas treatment or for regeneration of filters and/or catalytic converters.

Advantages of the Invention

According to the present invention, on the basis of a first variable which characterizes the injection quantity and a second variable which characterizes the angle setting at which the injection quantity is metered, a third variable which characterizes the torque supplied by the engine is determined.

On the basis of a fourth variable which characterizes the driver's intent, a fifth variable which characterizes the torque desired by the driver is determined. The third variable and the fifth variable are analyzed for the purpose of fault monitoring. This procedure according to the present invention permits reliable and accurate fault detection, in particular in the area of fuel metering and/or detection of the driver's intent. It is especially advantageous here that the second variable which characterizes the angular position of the crankshaft or the camshaft during the injection is taken into account. It is therefore possible to take into account the influence of the injected fuel on the torque supplied by the engine. The setpoint or the actual value of the start of injection, the start of delivery, the start of actuation or another corresponding variable is preferably used as the second variable.

It is especially advantageous if the actuation duration of an output stage of a solenoid valve or a piezoactuator is used as the first variable. By using actuation signals for the output stage, it is possible to test the functionality of the entire control unit.

It is especially advantageous if the fourth variable corresponds to the position of an operating element. This also makes it possible to detect faults in the area of processing of the output signal of the operating element.

It is advantageous if a fault is detected when the third variable and the fifth variable differ by more than a threshold value. Through this procedure, it is possible to detect faults in the entire signal path of the control system. These include in particular faults in the area of analysis of the input variables, calculation and determination of the output variables.

Due to the fact that the fault monitoring may take place only

in certain operating states, this makes it possible to reduce complexity. Furthermore, a more accurate fault detection is possible because fault detection is not performed in states in which no unambiguous results may be derived.

Advantageous and expedient embodiments and refinements of the present invention are characterized in the subclaims.

Drawing

The present invention is explained in greater detail below on the basis of the embodiments illustrated in the drawing. Figure 1 shows a block diagram of the device according to the present invention, Figure 2 shows a detailed diagram of the device according to the present invention, and Figure 3 shows a flow chart to illustrate the method according to the present invention.

Description of the Exemplary Embodiments

The procedure according to the present invention is described below on the example of the control system of a diesel engine. However, the procedure according to the present invention is not limited to the use with a diesel engine. It may also be used with other engines in which there is a correlation between the amount of fuel injected and the engine torque, and it may be used with systems in which there is a definite correlation between the amount of fuel injected and some other variable to be monitored.

Figure 1 shows the essential elements of the device for controlling an engine. A final controlling element is labeled 100. This final controlling element 100 determines the amount of fuel to be injected into the engine. It is preferably a solenoid valve or a piezoactuator. The final controlling element of the engine (not shown) allocates a certain amount of fuel, depending on the duration of a actuation signal.

Final controlling element 100 receives actuation signals from a unit 110 labeled TPU. The TPU here supplies signals which specify the start of injection and the end of injection. An output stage (not shown) in the final controlling element converts these signals into actuation signals for actuating various switching means.

Therefore, TPU 110 receives corresponding signals from a control system 120. Control system 120 processes sensor signals of various sensors 130 which supply signals, for example, with regard to driver's intent FP, speed N of the engine and other operating characteristics or environmental variables.

In addition, a watchdog 140 is provided and it receives the output signals from various sensors as well as the output signals of the TPU. Watchdog 140 sends corresponding signals to control system 120 and, in an advantageous embodiment, to a display 150. As an alternative, it is also possible for display 150 to be actuated by control system 120.

This device operates as follows. On the basis of various operating characteristics such as the engine speed and the driver's intent in particular, control system 120 calculates the time at which injection is to take place and the amount of fuel to be injected. The amount of fuel to be injected is then metered to the engine by final controlling element 100 and results in a corresponding torque.

In addition to the amount of fuel which is metered to generate torque, additional amounts of fuel are metered in each metering cycle or in individual cycles. Thus, for example, it is possible for a pre-injection to take place before the actual fuel metering in order to reduce noise. In addition, there may also be a post-injection after the actual injection. The post-injection introduces hydrocarbons into the exhaust gas, among other things, which in turn causes an increase in

temperature of the exhaust gas. In addition, these hydrocarbons may trigger reactions in a catalytic converter or particle filter downstream from the engine, where these reactions are necessary to keep the catalytic converter and/or particle filter functional.

In particular the post-injections, which are necessary for an exhaust gas aftertreatment system, do not contribute to the torque supplied by the engine. Other partial injections make only a reduced contribution to the torque.

Watchdog 140 processes the input signals of control system 120. Watchdog 140 in particular enters the values of the accelerator pedal position sensor. This is in particular the output signal of an AD converter of accelerator pedal sensor 130. In addition, watchdog 140 analyzes the last detectable value, e.g., the actuation duration, and calculates whether these values are plausible, preferably independently of the normal quantity control. For example, if the accelerator pedal position assumes a large value and the actuation duration signal assumes a large value, this is recognized as a plausible value.

Such a procedure requires a procedure adapted to the injection system because watchdog 140 must take into account whether there has been, for example, a post-injection in the corresponding operating states. Consequently, watchdog 140 and the plausibility check in particular must be adapted individually to the injection system.

According to the present invention, independently of the injection system, the data of each injection over 720 degrees of crankshaft angle of rotation is made available over a defined interface. To do so, a variable corresponding to the amount injected and another variable corresponding to the angular position at which injection takes place are stored for each cylinder and each injection. With this information it is

possible to determine the torques formed in the cylinder and perform a plausibility check with other input variables.

Due to the fact that a uniform interface is provided, it is necessary only to adapt the determination of the position and amount of fuel specifically to the injection system. Monitoring for plausibility may be performed in a similar manner for all systems. In addition, the data detected is intended for calculating the instantaneous engine power on the basis of the angular position of the crankshaft and the amount of fuel.

This monitoring is illustrated in detail in Figure 2. Elements already described in conjunction with Figure 1 are labeled with the same reference numbers in Figure 2. The output signal of TPU 110 goes to a table 200 and from there to a torque determination unit 210. The output signal of torque determination unit 210 goes via a torque summation unit 220 to a logic unit 230, which in turn supplies a corresponding output signal to display 150 or to control system 120. The output signal of a torque characteristics map 240 which receives output signals FP and N from sensors 130 as input variables is sent to the second input of logic unit 230.

This device functions as follows. The estimate of the indicated torque is based on a variable which characterizes the injection quantity metered and a variable which characterizes the angular position at which the fuel quantity is metered. The start of injection and the injection duration are preferably read out of the corresponding registers of TPU 110. Instead of the injection duration, the corresponding injection angle may also be used. The start of injection indicates the time or angular position of the crankshaft at which the injection takes place. The injection duration defines the duration of the injection and the angle traversed during the injection.

The actual starts of injection and injection durations or the times or angular positions at which the actuation of the final controlling element takes place may be read out of the TPU. A fuel quantity is determined on the basis of the injection duration. The determination of the amount from the actuation duration takes into account, for example, the fact that the actuation of the final controlling element lasts longer than the actual injection. The amount of fuel determined for each injection is entered into table 200 separately for each cylinder together with the start-of-actuation angle. This table contains all the injection events of a cylinder over 720 degrees of crankshaft angle. In addition, the cylinder number is also stored in the table as an identification feature. To ensure data integrity, a counter is also incremented each time the last event is entered into the table. For each cylinder, a message is created with the table layout and is managed by the operating system. This rules out the possibility of access conflicts due to simultaneous processing. In addition, it is possible to adjust the memory demand to the number of cylinders required with no problem. The injection quantity and the respective start of injection are determined in the table, preferably with synchronization of angles.

Table 200 forms the interface between the control system and the watchdog. The message having the table layout is the same for all injection systems.

In torque determination unit 210, an indicated torque is calculated from this data for each cylinder and sent to torque summation unit 220. Torque summation unit 220 calculates indicated torques which are added up for all cylinders with synchronization.

Then an indicated torque determined over a sampling period is available at the output of torque summation unit 220.

In parallel with this, a variable which characterizes the

driver's intent is determined on the basis of accelerator pedal position FP and rotational speed N by using a torque characteristics map 240. This variable and the variable which characterizes the indicated torque are checked for plausibility by logic unit 230 and checked for errors if deviations are found and preferably a corresponding display 150 is actuated.

Instead of torque characteristics map 240, a calculation may also be performed by using a formula. Furthermore, other variables or additional variables in addition to the accelerator pedal position and rotational speed may also be used.

Figure 3 illustrates the procedure on the basis of a flow chart. In a first step 300 setpoint torque MS is calculated from the rotational speed and accelerator pedal position FP. A subsequent query 310 checks on whether there are operating states in which a plausibility check is possible. If this is not the case, step 300 is performed again.

If there is such an operating state, then in step 320 the indicated torque is determined for each individual cylinder. To do so, the actuation duration is weighted with the crankshaft angle and the torque thus indicated is determined per injection. This determination is preferably performed for each partial injection, i.e., for pre-injections, main injections and post-injections. Fuel quantities metered in post-injection are preferably weighted with a value of zero because they do not make any contribution to torque. Actuation duration, main injection and pre-injection determine the indicated torque of the respective injection according to a preselectable function.

In subsequent step 330, the individual indicated torques are integrated over a plurality of partial injections and/or preferably over a plurality of cylinders, and actual torque MI

is determined from this. Then in step 340 the absolute value of the difference between setpoint torque MS and actual torque MI is calculated. Subsequent query 350 checks on whether the absolute value of torque difference MD is greater than a threshold value SW. If this is not the case, step 300 is performed again.

If absolute value MD of the torque difference is greater than a threshold value, then a check for faults is performed in step 360. Threshold value SW is selected so that possible tolerances in determination of the torque do not lead to triggering of a fault.